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CHOOSING A MICROCOMPUTER SYSTEM FOR APPLICATIONS IN THE INDONESIAN NAVY

by

Rachmat Sobandi

March 1986

Thesis Advisor: Norman F. Schneidewind

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This thesis addresses the contemporary microcomputer system, and the potentialities of using this technology for a number of applications in the Indonesian Navy.

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Choosing a Microcomputer System for Applications in The Indonesian Navy

by

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Captain, Indonesian Navy
B.E., Naval Electronic School, 1972

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN INFORMATION SYSTEMS

from the

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March 1986

ABSTRACT

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I. INTRODUCTION

Computer technology has advanced at a phenomenal rate during the last two decades and progress is expected to continue. The military, in particular U.S. Department of Navy, has long been a pioneer in the development of computer systems. Varied applications have been developed, including using embedded-computers in combat systems, real-time multi-processors in command-and-control system and many computer-based information systems similar to those used in business applications [Ref. 1].

The Indonesian Navy also has been using computer systems for several years. These computer systems are used primarily to provide information for management [Ref. 2]. Since the cost of operation and maintenance is much higher for the early-generation computer and the scarcity of personnel expert in the computer field, only a few computer systems were installed.

Microcomputer technology, which came into existence in 1971, has grown from the low performance of Intel's 4-bit 4004 microprocessor to the high performance 32-bit word length of the Intel's iAPX 432 microprocessor family in 1981 [Ref. 3]. This means that the new microcomputer is capable of addressing tens of megabytes of main memory spaces; it

is similar to the capacity of a mainframe ten years ago. The price of hardware also decreased significantly. A complete microcomputer system which can run for a small business will now cost only a few thousand dollars. Moreover, software vendors offer a lot of application softwares that can be used by the end user without any expert personnal required to operate those softwares. This era of the computer industry offers the opportunity for the military, the Indonesian Navy in particular, to use this technology for appropriate applications.

The intent of this thesis is to give the management of the Indonesian Navy, the necessary information and background in the area of microcomputer systems and the potentialities of using this technology for a number of Navy applications.

Chapter One presents this introduction. Chapter Two presents the background of computer usage in the Indonesian Navy. The possible areas of application in which the microcomputer can be used will be discussed in Chapter Three. The microcomputer hardware and software characteristics are discussed in Chapter Four and Chapter Five. Furthermore, a model for selecting a microcomputer system for a specific application in the Indonesian Navy is presented in Chapter Six. Finally Chapter Seven will contains conclusions and recomendations.

II. BACKGROUND

A. OVERVIEW

The Indonesian Navy entered the computer age in the middle of the 1970's when the Navy Personnel Administration Office (Janminpersal) purchased a BOUROUGHS 1700 series minicomputer for personnel application system as part of a project named Personnel Electronic Data Processing System (SPEDO PERS). This project was initiated by the need to have a better personnel management information system. A census of all Navy employees, including military and civilian was conducted in 1971, prior to the establishment of the computer installation.

A few years later, the Navy's decision makers realized that a computer based information system was also needed for other functional areas, including material, inventory and financial systems. For this reason, the Navy decided to change the SPEDO PERS project to a formal organization within the Navy called the Navy Data Collecting and Processing Center (Dispullahtal). The new hardware, a Sperry Univac System/80 was installed to serve new applications.

Until recently, the application systems run by Dispullahtal operated basically in a batch mode and file processing system, however work on database personnel system is near completion.

The data which has been collected by Dispullahtal, primarily comes from Functional Managements (Binfung) within the Navy headquarters such as the Navy Personnel Administration Office (Janminpersal) for the personnel application system, and the Navy Comptroller Office (Jankual) for the financial application system.

B. MICROCOMPUTER AGE

The introduction of microcomputer systems to Indonesia in the early 1980's, created a new era in using computers in the Indonesian Navy. Microcomputer vendors offered an inexpensive system, with end user orientation, and a capability to run several office applications.

The TRS 80 model II, Fujitsu, and the Altos computer are examples of microcomputers that were purchased by some offices at Navy headquarters. The small memory size of the first microcomputer generation, created limitations in using these computers. The common applications were word processing and a spread sheet.

However, the continuing to improve microcomputer capabilities, its speed, memory size, and peripherals attached to it, the microcomputer today nearly has the same capability as a minicomputer did several years ago. Now it is possible to use it for more real applications in addition to word processing system.

In the next chapter, the author will address the various areas of application for the Indonesian Navy in which a microcomputer as a stand-alone computer system will help many potential users solve their problems.

III. VARIOUS NAVY APPLICATIONS

A. UNIT LEVEL COMMAND SUPPORT

The Unit level command is the smallest unit identified in the Indonesian Navy organization. These commands are spread throughout the archiepelago.

The function of this command basically is to support the Naval Fleet whenever it operates in its area command. This command typically has a few hundred employees, both military and civilian.

The Commander of the Unit level command is responsible for maintaining personnel, facilities and budget allocation to this command. Regular reports of personnel, status data of inventory and budget spending are submitted to the higher level command and the Functional management at the Navy headquarters.

Until recently, all applications in unit commands are done manually.

B. DECISION SUPPORT SYSTEM

Manager and Staff level at Navy headquarters had received information processed by Dispullahtal in the form of summary reports. These summary reports are by product of batch oriented processing (personnel, inventory, and financial application) and come to the desk of decision maker in

the fixed format. However, this information is only part of the information needed for decision making. The Manager and Staff at the Navy headquarters are planners. They need more than fixed format summary reports. They want to play with their data, to improve the effectiveness of their decision making. Today, the advanced topic of Information System called DSS take this specific need of information system by the decision maker as its object study.

To specify the requirements for DSS, Eric D. Carlson [Ref. 4] made a series of observation about decision making and decison makers:

Decision making:

1. There are a variety of decision-making processes, so the DSS should support multiple processes.
2. Different types of decisions have different data processing requirements, so DSS needs to be flexible in order to support different types of decisions.

Decision makers:

1. Decision makers rely on conceptualizations in making decision, so a DSS should provide familiar representations (e.g. charts and graphs) to assist in conceptualization.
2. Decision makers perform Intellegence, Design, and Choice activities while making a decision, so a DSS should provide operation which support these activities.
3. Decision makers need memory aids, so DSS should provide memory aids which help carry out the decision-making process.
4. Decision makers exhibit a veriety of skills, style knowledge, so a DSS should help decision makers work in their own idiosyncratic ways.
5. Decision makers expect to control aids which help decision makers exercise direct, personal control.

The capabilities to present information in the form of graphics and color attribute, instead of just report of numbers and characters, and the availability software and hardware to communicate with the mainframe, the microcomputer can be used as a tool for supporting the decision support systems.

Presently, software vendors offer many DSS softwares that can be run on a microcomputer. Such software includes: Lotus 1-2-3 form Lotus Development Inc., Knowledgeman from Micro Database System Co., IFPS, and Expert Systems.

The current application that recently needed by the manager in the Navy headquarters is the Planning and Budgeting system.

C. RESEARCH AND DEVELOPMENT

The unique requirements and professional tasks in this field make it hard to schedule this application in the batch mode environment. The researcher needs information in ad hoc fashion and sometimes full computer support is required. The microcomputer, with appropriate softwares could reduce time consuming calculations and paper work.

The common requirements for this kind of application include mathematical programming, graphic representation, database information required for research, and wordprocessing for reports.

The Indonesian Navy Research and Development Office maintains four labs in four different locations:

1) Flatform Lab,
2) Weapon System Lab,
3) Electronic Lab, and
4) Biology and Chemical Lab.

D. TRAINING AND EDUCATION

The management of the Indonesian Navy was concerned about the quality of training and education in relation to the modernization of the equipment and weapon systems within the Indonesian Navy. In the early 1980's the Indonesian Navy started a program to replace some old ships and weapon systems with a new generation using the latest technology. The first modern generation of ships was built in the Netherland and has been operating for several years. These ships are equipped with computers on board. The simulation programs of the ship's computer system can be made by using microcomputer and installed in training commands.

The personnel who will be assigned to operate this equipment need to have some type of computer background. The microcomputer as a training aid will give the military sufficient skill that is required for the next assignment.

The Indonesian Navy maintains three Training Commands:

1) Naval Academy,
2) Naval Education and Training Command,
3) Naval Command and Staff College.

IV. MICROCOMPUTER HARDWARE CHARACTERISTICS

A. WHAT IS A MICROCOMPUTER?

Microcomputer systems as any other contemporary digital computer systems, consist of five components functionally independence parts: input, memory, arithmetic and logic , output and control units. This computer structure is called a von Neumann machine as shown in Figure 4.1.

The input and output units (I/O), are able to communicate with the external world. The main memory stores programs and data on which they operate. Program instructions are executed in the arithmetic and logic unit of the Central Processing Unit (CPU). The control unit of the CPU is responsible for fetching instructions and data from main memory into the CPU for execution, and for storing results back into main memory. The control unit is also responsible, either directly or indirectly, for the sequence of actions needed to move program and data between the I/O and the main memory or the CPU.

The function of control and arithmetic and logic unit are combined in a tiny silicon chip called microprocessor. The power of microcomputers depends on the microprocessor used. There are a variety of microprocessor used as a CPU in the microcomputer, ranging from a 8-bit word to a 32-bit

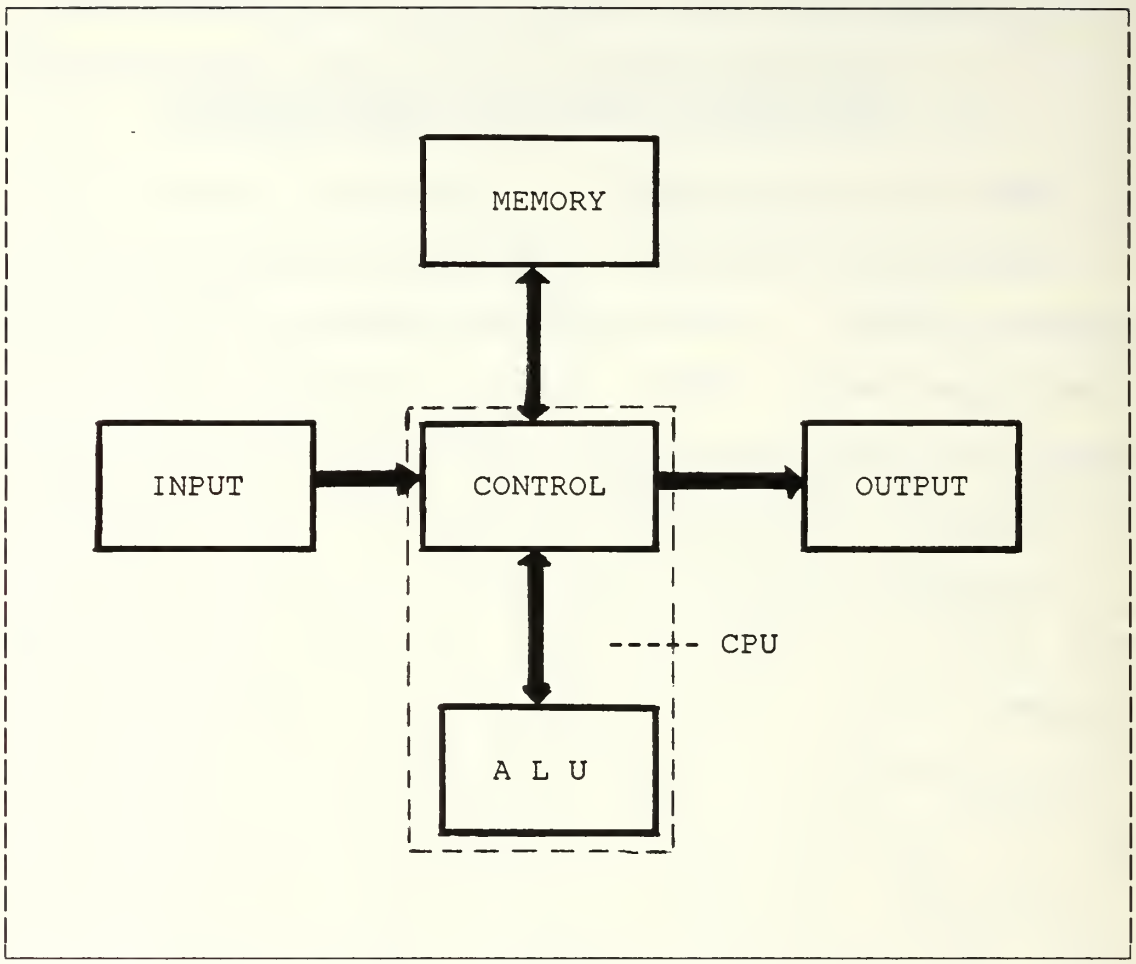

Figure 4.1 Computer Hardware Components.

word microprocessor. The longer the word, the more powerful microprocessor, hence the more powerful the microcomputer.

A microcomputer system is usually supplied with a keyboard, a display unit, one or more diskette drives and a printer. Additional peripherals are widely available, either from computer vendors or independent sources.

B. MICROCOMPUTER BUS-ORIENTED ARCHITECTURE

1. Concepts

Most microcomputers tend to be organized along bus lines rather than the more classics von Neumann approach. A bus-oriented computer contains all functions of the classically organized machine. Instead of information flowing from function to function, however, all function are connected to all other functions in the bus-oriented microcomputer. The control section of the CPU decides which of the functional units is to originate the information to be used and which of the functional units is to receive that information. Figure 4.2 shows the general concept of bus-oriented microcomputer [Ref. 5].

2. Bus Function

The data bus carries either instruction to be decoded or data to be manipulated. It is bidirectional; that is, it carries data from the microprocessor to other units of the microcomputer at one time, and at other times data maybe carried from another unit of the microcomputer to microprocessor. Direction of data flow is determined by control section of the microprocessor. Microcomputer word size determines the number of connecting lines in the data bus.

A unidirectional address bus contains a binary code representing the location of the next data to be used or the

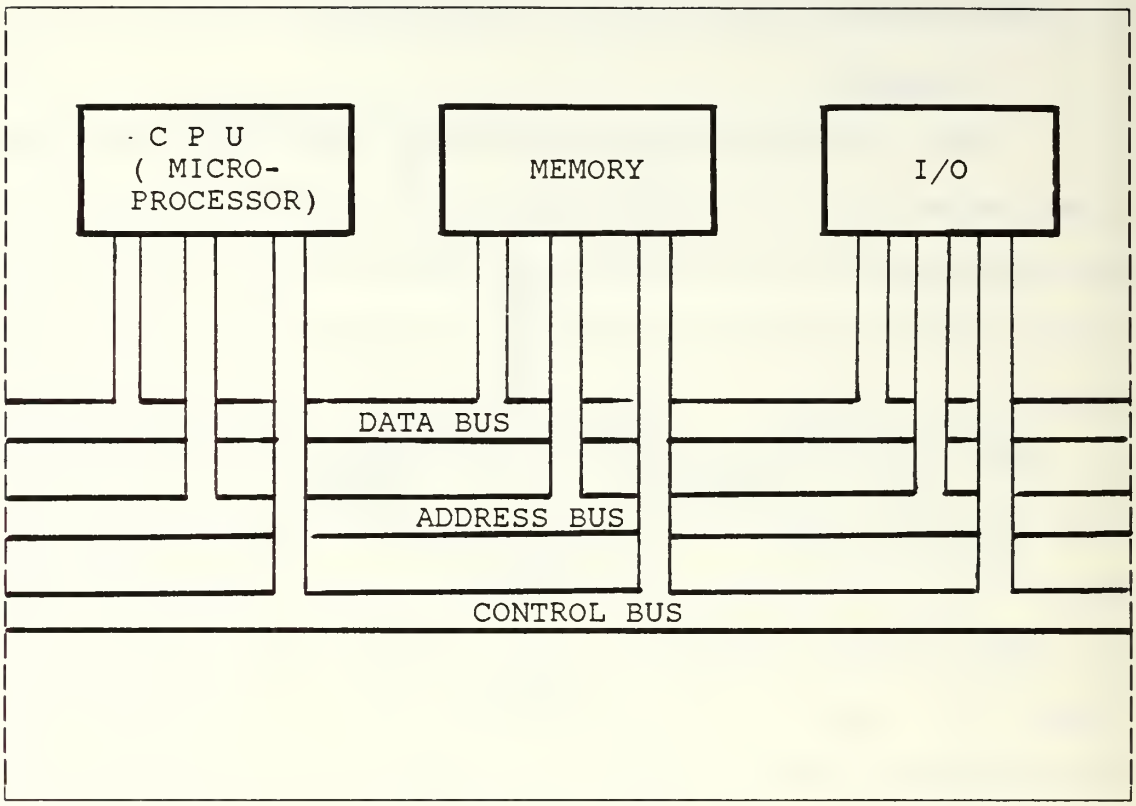

Figure 4.2 Bus-oriented Microcomputer.

location where data are to be stored. Many microprocessors also used the address bus to identify input/output devices that are to be used. Thus, although data flows in only one direction, the address bus perform dual functions. The control section of the microprocessor supplies a signal to indicate whether the input/output device or memory is to act on binary code on the address bus. Total memory size fixes the number of interconnection provided by the address bus. A memory with 65,536 storage locations for examples, requires 16 address lines in the address bus.

The unidirectional control bus carries information describing what information is to be performed, which functional units are to respond, and so on. Control bus size is determined by the number of control signals required for the microcomputer in use, and is determined by the designer. Typical control bus signals include system timing, memory read/write, input read/write, and output read/write.

C. CPU ARCHITECTURE

1. Internal Microprocessor Organization

The essential components of microprocessor as shown in Figure 4.3 are listed below [Ref. 6].

a. Arithmetic and Logical Unit (ALU)

Performs the arithmetic and logical function as specified by the computer instruction, e.g. adding a byte to the contents of the accumulator.

b. Instruction Decoder

Set up control signals and activates operations as dictated by current instruction.

c. Registers

Instruction Register: contains a current instruction.

Flag: stores flags set by certain operation.

Accumulator: holds results of arithmetic and logic operations.

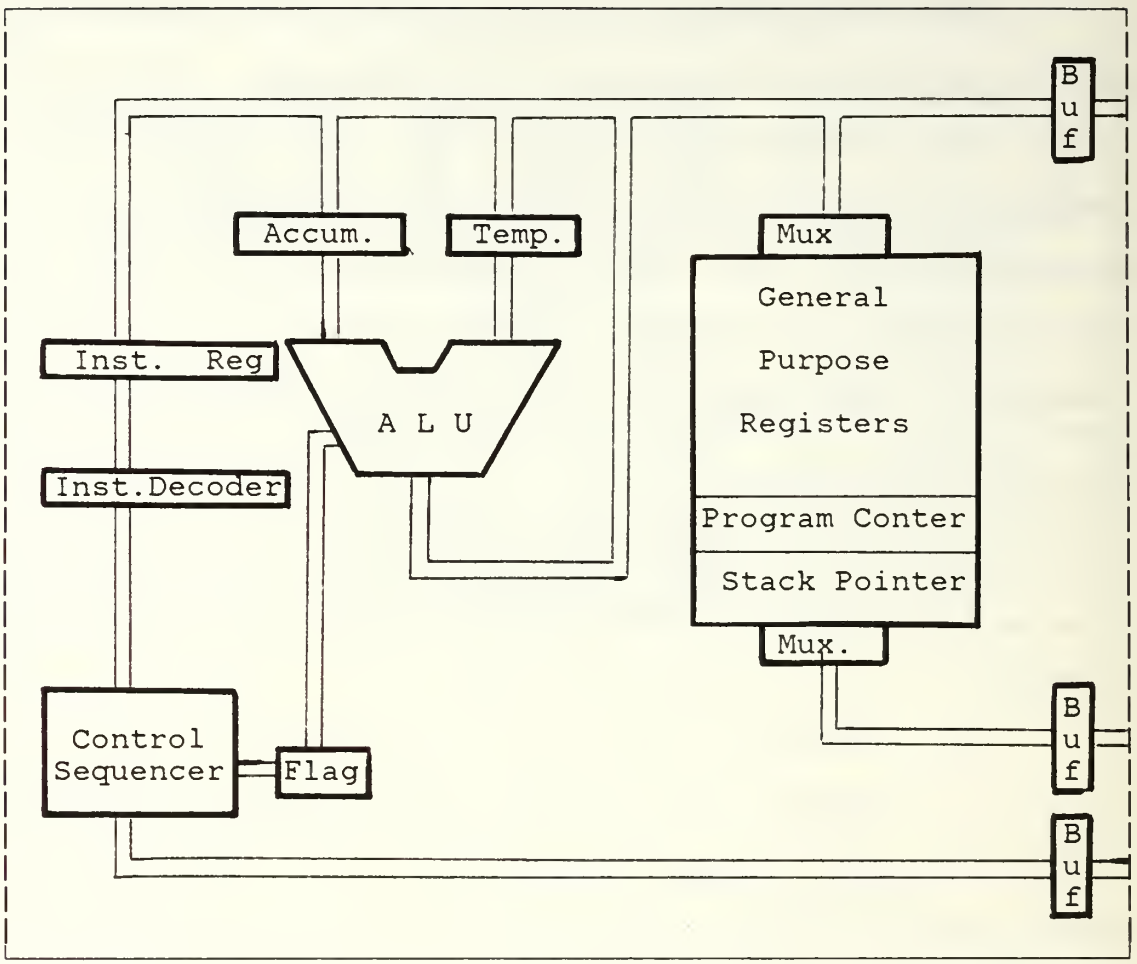

Figure 4.3 Microprocessor Architecture.

Stack Pointer: contains address of top of the stack.

General Purpose Registers: user for temporary storage to speed up processing and stores addresses.

Control sequencer: stores, transmits, and receives essential control signals for other units.

2. Instruction Cycle

The microprocessor operates in repetitive sequence of operations when performing its functions. The instruction cycle is the sequence of operation required by microprocessor to obtain information from either storage location on-chip or off-chip, and to perform the operation required by that information. Each instruction cycle is made up of one or more machine cycle (Figure 4.4) [Ref. 6].

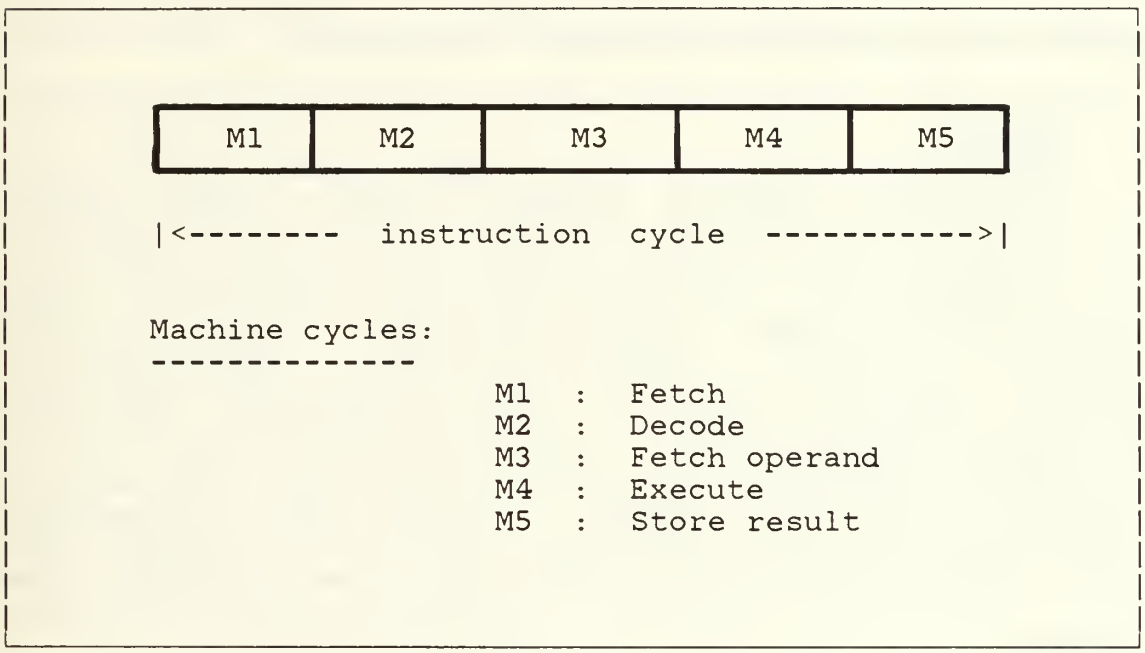

Figure 4.4 Basic Instruction Interpretation Cycle.

One machine cycle is used for each byte information to be obtained, or for each basic operation to be performed. The first machine cycle of each instruction is always a "fetch" machine cycle, and consist at least four timing

periods. The first period moves the content of the program counter onto the address bus for the purpose of obtaining information either input/output or memory. During the second timing period the program counter is incremented so the next location to be accessed is readily available for use. The address noted in the first time period to temporary storage register. Depending on the operation to be performed the fourth and fifth timing periods are used to move information between register and other portion of the microprocessor, or perhaps perform simple arithmetic operations.

D. MEMORY

Microcomputer systems generally require memory storage of two types: main (internal) memory and auxilary (external) memory. The main memory serves many uses. Essentially it is used to store the series of instructions that make up a program as well as data to be used and their results. In addition to the user program, several other programs may also reside in main memory at the same time including system software.

Main memory can be divided into two areas: volatile and non-volatile memory. Volatile memory requires power to obtain the memory contents. Non-volatile memory contains permanent information in which will not change even with the lack of power. Non-volatile memory is often refered to the generic name ROM (Read Only Memory), on the other hand the

volatile memory is refered to RAM (Random Access Memory). Bootstrap programs, assemblers and compilers, and routines to operate input/output devices all fall into the category of candidates for ROM storage applications. External data (information brought from outside), results of calculations and data movement, information to be printed are stored in RAM.

The more memory that is available the larger the programs or data that can be accomodated. The greater the accomodation, the greater processing capabilities in the shortest possible time. Today most 16-bit microcomputer typically have memory capacity of at least 128 kilobytes.

While main memory allows the CPU high speed access to data, it's storage capacity is limited . To compensate for this limitation, additional storage of data is required. Mass storage devices provide the computer with this type of service. Among the more common mass storage devices for microcomputer are floppy diskettes and harddisks (see Peripheral Devices section).

E. INPUT/OUTPUT CONTROLLER

Input/output controllers interface external devices with the CPU and perform control, data transfer, and buffer tasks of some complexity. The CPU demands data in one format while (for example) floppy diskette drive can only deliver it in another and each has its own speed of operation. All

data transfers are subject to stringent error checking procedures and the peripheral devices also normally demands particular control actions, e.g., the read/write head of floppy diskette drive must be raised and move to the appropriate track. The I/O controllers which oversee such tasks are normally located on separated printed circuit boards which can be inserted into motherboards on the microcomputer.

Data transfer may be performed in a parallel or serial mode. In the parallel mode each bit is sent along an individual line. With an 8 bit data bus clearly eight lines are required and bytes are sent along these lines one after another. In the serial mode the bits of individual bytes, are sent as a sequential set of pulses. Parallel transmission is faster but it requires more lines so it is employed inside the microcomputer where speed of transfer is a prime requirement and transmission distance are short. Serial transfer requires only one line and is used when the communication links are comparatively long.

The three standard interfaces are commonly used in microcomputer industry, there are S-100 bus, IEEE Standard 488 bus and the RS232 interface.

F. PERIPHERAL DEVICES

A computer peripheral is a device that performs an input/output action. The microcomputer peripherals include a

keyboard, video monitor, printer, floppy diskette and harddisk.

1. Keyboards

Keyboards differ in layout, keystroke action and key movement performance. The importance of the keyboard depends on the nature of microcomputer application; with any text editing, word processing or large data entry system the keyboard design is of critical importance. In application- where the operator will only make minimal data entries the cheaper keyboard might be suffice.

The keyboard layout comprises, usually, three sets of keys: alphabetic, control and numeric. the numeric are often located in separate section and this arrangement greatly facilitates the inputting of mass numeric data.

2. Display Unit

The importance of the display will vary with the expected application of the microcomputer. Some application may involve high usage of print output or great deal of mathematical processing with comparatively little screen activity. On the other hand text editing, extensive data entry or retrieval, computer based training and engineering design system will involve operator receiveing a large volume of text, or graphics, information from the screen.

The text and graphics output depends upon the video monitor and electronic circuits that generate the displayed

shaped corresponding to the specific code signals. Text editing applications demand a full range of easily discernible upper and lower case characters. Most systems provide reverse video facilities. This facility provides for highlighting of part of the text. Also the color monitor is another option that is available today.

3. Floppy Diskette Drive

Floppy diskettes conventionally come in three sizes, 8 inches, 5.25 inches and 3.5 inches of diameter. The speed of rotation is typically 300 rotation per minute for 5.25 inches drives. The comparatively low speed arises because the read/write head is in contact with the disk surface and it both limits the input/output data rates and increases the data access time.

The capacity of a floppy diskette depends upon the number of track per inch, the number of sides magnetized and the method of coding the signals on the disk. The early 5.25 inches diskette had 48 tracks per inch, 40 tracks per side and so approximately 3000 bits per inch giving 125 kilobytes on one side. It is now possible to attain storage capacity up to 1 megabytes by doubling the bit density, track dnsity and using both sides of the diskette.

4. Harddisk Drive

Hardisk drives normally employ 5.25, 8, and 14 inches hardisks that are fixed in the drive. This permanent

disk design reduces the complexity of the drive mechanism and hence the cost. They provide high on-line storage capacity, typically upwards from 5 megabytes for 5.25 inches disks. The higher capacity of harddisks is derived from the greater recording density with some 960 tracks per inch and 9000 bit per inch. The data transfer rate can be of the order of megabytes per second and these devices are required when the user demands fast access to a large mass of data.

5. Printers

A printer accepts a stream of electrical impulses from the computer and produces hardcopy text or diagrams. Printer may be categorized as having fully formed character or dot matrix printing heads. The former include teletype-writer, electric typewriters, daisywheel and thimble printers which produce each character in one action. The dot matrix printer creates a character as a series of dots with successive movement of a print head capable of producing a one or two pattern line vertical dots. Fully formed char-acter printer tend to be comparatively slow and expensive but produce correspondence quality printouts. the dot matrix printer is favored by microcomputer user because it is fast, cheap and relatively silent.

G. HARDWARE TREND IN THE MARKETPLACE

Several new models based on 32-bit microprocessor illus-trated the trend away from 8 and 16-bit microprocessors.

Internal memories of a megabyte or more also become more common, particularly with the many IBM PC-AT compatible computers, that available in 1985.

Another trend that may be identified is more towards the implementation of multi-user operation through distributed systems. Distributed computer systems consist of a number of single user microcomputers connected together through a common data lead to form a network. The microcomputers may share expensive devices such as printer and disk drives, or exchange information such as electronic mail.

V. MICROCOMPUTER SOFTWARE CHARACTERISTICS

A. INTRODUCTION

The computer software is the detailed set of instructions to be obeyed in performing a specific task; it is either a program, a set of programs, or interrelated suite of programs. The art of using a computer is to select the software that provides sufficient flexibility to perform the necessary tasks, and sufficient facilities to minimize the detail design and development works to be perform by the user.

There are three levels of software: operating systems, programming languanges, and application softwares. Each level builds upon the preceding one.

B. OPERATING SYSTEMS

The operating system is a group of programs that allocate and control hardware resources. Some of the specific functions provided by the operating system include:

- the supervision of the microprocessor
- control and coordination of input/output and storage function
- serve as an interface between the user and the hardware machine

The many programs that reside within the operating system can be categorized as either: Control Program, which

care such tasks as hardware resource management, data management in and out of the CPU, and management of I/O data flow, or Processor Programs, which perform such tasks as compiling high level languages, various service/utility functions, and providing system performance monitoring.

There are several operating systems can be used for a particular microcomputer. Ultimately, all these operating systems accomplish the same task: they give the user control of the computer. However, each operating system has it own way interacting with the hardware, other software, and the user. The operating system give the computer 'personality'.

Several operating systems for microcomputer will be described. First CP/M , the most popular operating system for early generation of microcomputer (8-bit) and continue to be used in the early generation as well. The PC DOS and the Macintosh operating system followed the popularity of their respective hardware acceptance. The UNIX operating system, seems to be the operating system for the next generation of microcomputer (32-bit) [Ref. 7].

1. CP/M

CP/M stands for Control Program/Monitor, originally is the operating system for the 8-bit microcomputer (with Z-80 and 8080 microprocessor). It design in 1973 by Gary Kindall and produced by Digital Research, Inc. More than 1,000,000 microcomputer system run on the CP/M family of

operating systems [Ref. 8]. The family of CP/M operating system, include:

MP/M: a proprietary multiterminal operating system supporting real-time multiprogramming at each terminal. This operating system executing on the 8080, 8085 microprocessor.

CP/M-86: is the version of CP/M that is used by microcomputers with 8086 or 8086-related microcomputer (16-bit as IBM PC).

MP/M-86: a multi-user, 16-bit multitasking operating system which upward compatible from CP/M, MP/M, and CP/M-86 operating system.

CP/NET: and advance distibuted processing operating system based on 8080, 8085, and Z80 microprocessor. The purpose of the CP/NET is to enable microcomputers to obtain access to common resources via network.

CP/M is a microcomputer disk operating system that resides at the top of user memory (RAM). It is functionally divided into three modules:

a. CCP (Console Command Processor)

All the commands type at the console are interpreted and send on their way by the CCP.

b. BDOS (Basic Disk Operating System)

BDOS contains about 39 functions which handle both disk and console I/O management. These functions are used both by CCP and by Transient Application Programs.

c. BIOS (Basic Input Output System)

The program segments of these section are used by the function in BDOS to handle the actual transfer of data to disk, printer, screen, and any other peripherals connected to the microcomputer.

2. PC DOS

The PC DOS is the operating system for IBM PCs, that originally came from MS DOS from the company named Microsoft Inc. IBM obtained the right to market MS-DOS for its system under the name PC DOS. Most of the IBM PC compatible microcomputers operate under MS-DOS [Ref. 8].

PC DOS is quite similar with the CP/M. It functionally divide into four areas: the disk handler, the non disk peripheral handler, the command interpreter, and utility programs.

a. Disk File Handlers

Disk file handlers are programs that transfer information to and from the disk drives. These programs maintain the directory, locate, place, or retrieve information on the disk, and perform several other built-in functions.

b. Non Disk Peripheral Handler

This set of software handles the keyboard, display, communication, and other similar devices.

c. Command Interpreter

Command interpreter has four functions:

1) handles device interrupts, the stop processing function, critical error handling, and end-of-program housekeeping,

2) batch file handling,

3) execute housekeeping commands its contains,

4) to load and execute programs from the disk.

d. Utility Programs

A utility program is a set of utility programs for housekeeping tasks. These programs format diskettes and harddisks, give statistics on the disk and memory, and compare diskettes and files. The utility programs reside on the disk and are loaded into memory for use.

3. UNIX Operating System

The UNIX operating system was developed by the Computing Science Research Group at Bell Laboratories in New Jersey. The UNIX system is mostly used in minicomputer and suitable for research and development environment. With the widening of the installed base of the UNIX operating system to small machines such as those using Motorola MC68000 and the Zilog Z8000 microprocessors, a market for this operating system now extents to the microcomputer.

The UNIX system has characteristics as an interactive, multitasking and also multiuser operating system [Ref. 9].

The UNIX operating system composed of three major parts.

a. Kernel

The Kernel is that part of the system which manages the resources of whatever computer system it lives on, to keep track of the disks, printers, terminals, communication lines, and any other devices.

b. File System

The file system is the organizing structure for data. The file system goes beyond being a simple repository for data, and provides the means of organizing the layout of the data storage in complex ways. The organization of UNIX's file system is sometimes called a tree structured file system.

c. Shell

The Shell is a program that interprets the command typed from the terminal.

4. Macintosh System Software

Macintosh system software consist of three parts.

a. Macintosh Operating System

This part of system software contains many components found in more traditional system. It includes the low level device drivers and interrupt handlers, an asynchronous I/O system, a memory management, a simple file system, a segment loader, and various utility routines.

b. Quickdraw Graphic Packages

This program would serve as a foundation for higher level software to make use of graphics.

c. User Interface Toolbox

A collection of various mangers and services intended to help a programmer develop application that conform to the Macintosh standard user interface.

C. PROGRAMMING LANGUAGES

The computer's CPU understands only one type of language which is called machine language. Machine language is a series of binary codes that represent data that the CPU can read. Since the humans are not in practice of communicating in binary code, high level language were developed so that we could express our programs in a more familiar form utilizing English terminology.

Systems software was developed to take our program written in high level language (source program) and convert it to the machine language (object program), so it can be executed by the computer. System software known as interpreters and compilers were developed to provide this function. Almost all microcomputer come with the ability to program in BASIC language by providing and storing the operating system and interpreter in internal ROM. Following are the typical programming languages that can be used in microcomputer.

1. BASIC

An interpretive language was developed to provide beginners with an easy introduction to programming. Its use exploded with the development of the microcomputer and it is perfectly good language for small application programs. Extensive application programs may be excessively slow when written in this language, and it's lack of block structure can make program development tedious and error prone.

2. PASCAL

This is a block structured language suitable for a wide range of application and becoming increasingly popular in the microcomputer sphere. The block structure facilities the development of very complex programs.

3. COBOL

This is the traditional language for large data processing organizations had geared to file transaction applications. It is somewhat verbose language and its popularity is self perpetuating because large data processing organization often have extensive investment, and expertise, in COBOL software which tends to discourage a switch to other language.

4. FORTRAN

Fortran is a popular language for engineers and scientists geared to programs involving extensive mathematical manipulations but lack text manipulation facilities and not suitable for business application.

5. PL/M

This is a microcomputer language derived from PL/1, which was developed to combine the advantage of COBOL and FORTRAN.

6. C Language

A programming language similar to PASCAL but more flexible and allows programmers to access hardware features. It is not a business data processing language and from this viewpoint less suitable than PASCAL.

D. APPLICATION SOFTWARES

Application software is any program that uses the computer to accomplish a specific task or solve a specific problem. There is a wide variety of application softwares available in the marketplace today, produced by both micro-computer vendors and from third party, software houses.

The application software packages can be grouped by their function as: wordprocessing, database management system, financial modeling, graphics, electronic mail and other data communication system, and standard application system.

1. Wordprocessing

This software offers facilities enabling any user to create document records, ranging from a simple letter or memo to a full length work papers or book such as student thesis. The user can easily edit these records, to form a

suitable layout for direct printing, or transfer to another machine for special typesetting or other form of output. Some wordprocessing also offers checking English syntax capability.

2. Database Management System.

A database management system offers general facilities for creating computer records, retreiving information from them to produce general or selective reporting. Relational database is a common type of database for microcomputers. A user allows access database in a query or programming mode by creating a macro program. A knowledge of programming is required for creating complex systems.

3. Financial Modeling

Typical of software packages for financial modeling are those which allow the video screen to be used as spreadsheet on which can be built up financial statements, sale forecast, budget headings, and other financial modeling and forecasting records. Today, more complex such software are available, which combine with the graphics capability and database management system. Lotus 1-2-3, Knowledgeman, IFPS fall in this category.

4. Graphics

Utility packages for graphics may range for simple software for monochrome two-dimensional business graphics facilities for statistical information in the form of bar or

other charts, to the complicated and complex for multicolorthree-dimentional graphics which can be used in a computer-aided design (CAD).

5. Electronic Mail and Other Data Communication Systems

With appropriate communication hardware and software facilities, document prepared using wordprocessing or program and other data can be sent to other microcomputer or even larger computer such as mainframe via communication network facility.

6. Standard Application Packages

This software is categorized as end-product softwares, either as complete business systems or routines incorporation in the other systems. Following are the examples of such systems:

- Payroll
- General ledger
- Sales order entry and invoices
- Stock control
- Production control

VI. MICROCOMPUTER SELECTION MODEL

A. INTRODUCTION

While microcomputers become more and more popular, their choice become more increasingly difficult and complex. There are more than fifty models available in the market manufactured by more than twenty vendors [Ref. 7]. At first glance, they all appear 'similar', but in fact, they differs in memory size, their expandability, peripherals used, price, etc. More importantly, none of these microcomputers clearly outranks all others in term of characteristics previously mentioned. Each of them has some unique features, but also lack some nice performance that the others have.

B. SURVEY ON MICROCOMPUTER SYSTEMS

There are two microcomputers that dominated the maketplace recently. The IBM PC-XT was launched in 1983 to elemi-nate some drawbacks of predecessor, the IBM PC, has a lot of flexibility to meet business applications. The success of the IBM PC has created the IBM-compatible computer market [Ref. 8].

Apple's Macintosh on the other hand, was designed in a small size, light weight at a moderate end-user cost. The Macintosh's design differs from the majority of microcomputer systems in the user interface that is provided by mouse [Ref. 10].

In this section the author will describe more detail about the architecture and features that are offerred from these microcomputers.

1. IBM PC-XT

a. CPU

The Intel 8088 microprocessor is used as the CPU in IBM PC-XT. This 16-bit nMOS microprocessor chip is a modified version of the 8086 and uses 8-bit data bus in place of the 16-bit bus used on the 8086 type. This processor can be paired with 8087 co-processor (optional) and is designed to provide high speed mathematical operations. This is to be about one hundred times more effective than 8088 alone. Figure 4.7 shows the registers which are accessible to the programmer.

For arithmetic and logic there is a bank of four 16-bit general purpose registers namely AX, BX, CX, and DX. The AX register is used as the accumulator, while BX acts as a base register for data addresses. CX acts as a counter and DX is used to address I/O devices.

Status flags and interrupt control are provided by 16-bit status register (ST) and there are four 16-bit address pointer registers. Register BP acts as a program base address pointer. SP is the stack pointer, and SI and DI act as index pointers giving source and destination adresses.

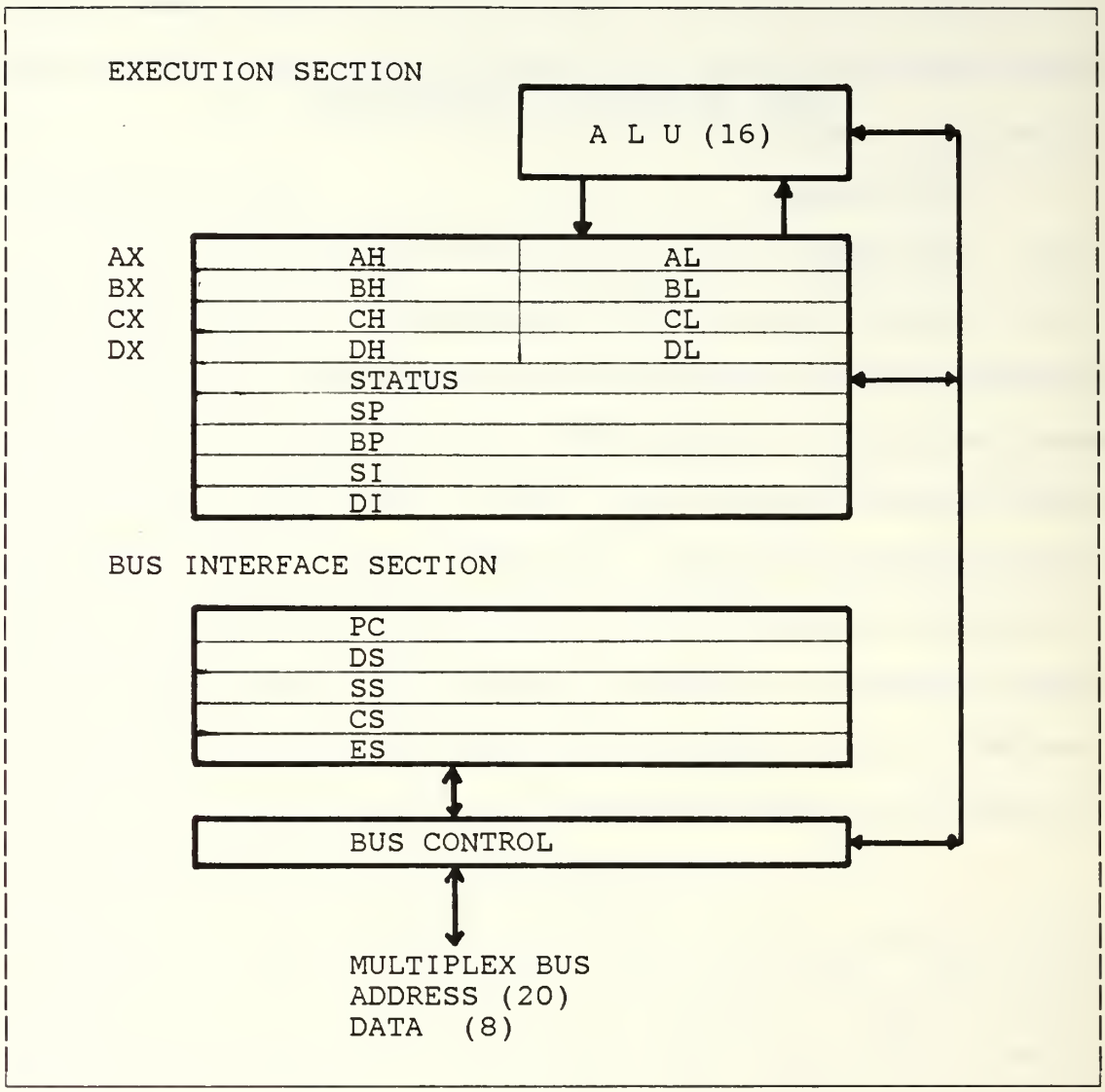

Figure 6.1 The Intel 8088 Internal Registers.

The 16-bit program counter (PC) allows access to 64 K byte of memory, but by using segmented addressing the total memory may be expanded to 1 megabyte. Four 16-bit registers provide segment addresses and in each case the contents of the segment register are shifted 4 bits to the

left and then added to the effective address to give a complete address of 20 bits. Segments may exist anywhere in memory and may even be overlapped. Four types of segment are supported. They are data (DS), stack (SS), program code (CS), and an extra segment (ES).

The IBM PC-XT operate with 4.77 MHz CPU clock. The execution time of an 8088 will be about 30% longer than for an 8086, since for many operations two bus accesses must be made for data instead of one. The average speed of the 8088 in the IBM PC-XT is approximately 0.65 MIPS (million instructions per second).

b. Memory

With 20-bit address bus, IBM PC-XT has a capacity to address up to 1 megabyte of memory locations. 256 kilobytes is allocated for ROM and the rest is alocated by RAM. The RIOS (ROM Basic Input/Output system) occupied 8K bytes, and the Cassette Basic Interpreter held 32 K bytes, for both total 40 K bytes. The rest of 216 K bytes is reserved for the future expansion. 128 K bytes of RAM space is dedicated to adapters, such as the monochrome or color graphics adapter. IBM PC-XT gives the standard 256 K bytes for user RAM. The user can expand RAM space with the memory expansion card up to maximum 640 K bytes.

c. I/O Channel

Eight I/O channels (IBM called expansion slots) in the IBM PC-XT actually are the extensions of the address bus. When a card is pluged into an expansion slot, the card becomes part of the computer system. These expansion slots allows the user to choose the appropriate input/output devices and to expand the system to meet his requirements. However, three of these expansion slots are already taken by the asynchrounous acommunication adapter, the floppy diskette and harddisk controllers.

d. Secondary Storage

The standard IBM PC-XT has one floppy diskette drive of 5.25 inches. This double sided and double density diskette is capable to store 360 K bytes of data. The internal harddisk has a capacity of 10 megabytes. The user can expand with the extension unit, another 10 megabytes hardisk.

e. Peripherals

The standard peripherals for IBM PC-XT are a monochrome video monitor and a serial printer. With expansion slots available, the user will able to configure this microcomputer corresponds to his specific needs. Color monitor, color plotter, modem for communication lines are some examples of peripherals that can be attcahed to the IBM PC-XT.

2. Apple's Macintosh

a. CPU

The heart of Macintosh is the MC68000 microprocessor produced by Motorola Semiconductor Co. Internally the 68000 has 32-bit wide data organization and very flexible array of working registers which give is a very high processing throughput. The address bus of 68000 use 23-bit to provide over 16 megabytes of directly addressable memory spaces. Figure 4.6 shows programable registers in the 68000.

The internal architecture of 68000 differs from many smaller microprocessor. The 68000 has no dedicated accumulator registers, instead it uses a bank of eight 32-bit general purpose register D0 - D7, of which any can be used as an accumulator as required.

There are also a further eight 32-bit address registers which can be addressing by the programmer. Of this register 7 is in fact two separate 32-bit registers which act as stack pointers, although only one will be in program operation at any given time. One operates as the system stack pointer and the other is the user stack pointer.

Another 32-bit register acts as program counter. Only the lower 23-bit of this register are used. The status register is 16-bit wide which provides a wide selection of conditional flags.

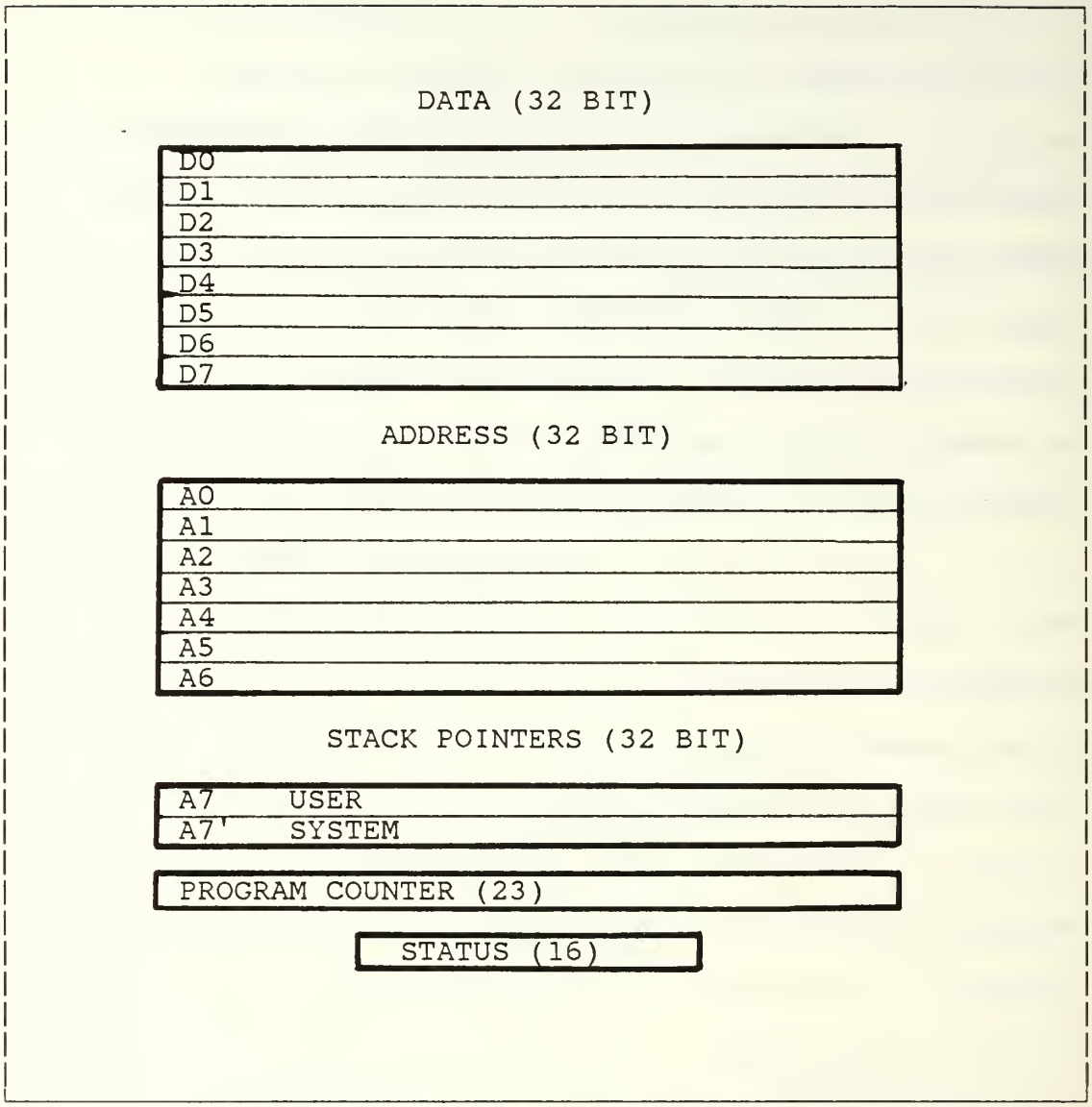

Figure 6.2 The Motorola 68000 Internal Registers.

To increase the speed of execution, the arithmetic and logic unit incorporates hardware for integer multiplication and division which may be called quickly by program.

The Macintosh operates at a clock speed of 7.8 MHz which is much higher than the IBM PC-XT (4 MHz). Seven levels of interrupt priority are provided by using the interrupt priority inputs, but only three were used by Macintosh.

b. Memory

The ROM connects directly to the system data bus. Macintosh has 64 K bytes of ROM and it contains low graphics primitif, operating systems, and user interface routines (called toolbox). All this programs and subroutines are coded in 68000 assembly language, so it uses memory efficiently.

The standard RAM is 128 K bytes and can be expanded up to 512 K bytes by substitusing 25 K-bit dynamic RAM chip.

c. Secondary Storage

Macintosh has only one diskette drive built-in the main unit. Instead of 5.25 inches diskette drive commonly used in many microcomputers, Macintosh uses Sony 3.50 inches diskette drive holds 400 K bytes. By using disk controller called IWM (Integrated Woz Machine) the disk transfer rate is 500 K bytes/second.

d. I/O Channel

Two high speed serial bus are provided to connect additional peripheral and communication line. These

channels can run in two modes: with an external clock it can transfer up to 1 megabytes/second, with internal clock only 230.4 kilobytes/second. The later is used to connect to the peripheral which need only a low to medium data transfer rate.

e. Mouse

A mouse equipment allows the user to input diagrams, to display and manipulate text of document in a user friendly manner.

3. Summary

To select which, of the two microcomputers described above, is better, is not easy. Each one is better for a certain application but may be less appropriate for another task.

To summarize, we can translate those characteristics in term of criteria, that can be used for further comparison using technique outlined in the following section.

a. Capacity

The capacity of a microcomputer can be translated as the capability to store amounts of data, both in the main memory and in the secondary storage. From the survey above, the IBM PC-XT's capacity is obviously superior than Apple Macintosh. The 256 K byte of main memory is above the average for most microcomputers in the marketplace. In addition IBM PC-XT has a standard of 10 M byte harddisk. As

a conclusion, the author gives a 'good' rating for IBM PC-XT, and an 'average' rating for Macintosh.

b. Expandability

Expandability can be stated as how big the microcomputer can be expand from the standard configuration to the future growth of the application system that will be operated. The number of I/O available indicates the rating of the expandability factor. Since IBM has 8 expansion slots, instead of 2 serial ports available in Macintosh, it is reasonable to put an 'exellent' rating for IBM PC-XT and 'fair' for Macintosh.

c. Processing Speed

Macintosh is faster compared to IBM PC-XT, not only by using faster clock cycle (7.4 MHz), but also by using direct addressing mode, instead of segmented-addressing mode in IBM PC-XT. Thus Macintosh has a 'good' rating, and IBM PC-XT on the other hand has a 'fair' rating.

d. User Friendliness

By using the mouse feature in the Macintosh, the user can get away from the frustation of using control keys for a large number of documents to be viewed. Eventhough third parties offers a mouse for IBM PC XT, the result is not as good as the Macintosh performance. IBM is about 'average' and Macintosh 'exellent' for this criteria.

e. Price

Both of these microcomputers have relatively the same price for the standard configuration. We can buy the IBM PC-XT standard configuration for $ 2,300 and $ 1,849 for Macintosh system. Both have 'average' ratings.

Table I shows the summary for those above criteria.

TABLE I

IBM PC-XT AND APPLE MACINTOSH COMPARISON

Criterion	IBM PC-XT	Macintosh
1. Capacity	good	adequate
2. Expandability	exellent	fair
3. Speed	average	good
4. User friendliness	average	exellent
5. Price	average	average

C. WEIGHTED CRITERIA-DECISION METHOD

1. General Characterictics

- Weighted criteria decision method allows analysis of several criteria at once.
- The decision criteria may be either quantifiable (e.g., cost, memory capacity, etc.) or non quantifiable (e.g., user friendliness, documentation, etc.).
- These decision criteria also presents contradictionary elements (e.g., cost and performance).

- Weigthed criteria decision method allows consideration of Decision maker a subjective evaluation.

2. The Weighted Sum Approach

The idea is to reduce a multiple dimension problem into a 'dimensionless' figure of merit for each alternative, and choose the one with the high figure [Ref. 11].

Mechanism:

. Establish a more or less exhaustive list of evaluation criteria.

. Consider all feasible alternatives.

. Investigate an assess alternatives according to criteria.

. Assign set of weights to the evaluation criteria (generally adding up to 100) which indicate the relative importance of each criterion.

. For each criterion, assign a rating using a scale (generally of a scale of 0 to 10) as a point of reference.

. For each alternative, multiply, multiple its ratings with their respective weights to get weighted ratings.

. For each alternative, add all weighted ratings to obtain overall figure of merit.

. Select the alternatif that have highest figure of merit.

D. EXAMPLE

The method described above can be implemented to choose a microcomputer for a specific application. Consider, for example if we will choose among two different microcomputer

systems described in the previous section (IBM PC-XT and Apple Macintosh).

This computer will be used in the Unit command field, firstable for budget evaluation by Planning Officer. Lotus 1-2-3 software has been choosing, and both of those microcomputer adequate to run this application software. This microcomputer also will be used later for personnel database system with a limited data elements as a need for local purpose in this command. Also a wordprocessing must be able to run for daily operations.

Based on those requirements, weight factor for each alternative criterion described in the previous section is shown in Table II.

TABLE II

WEIGHT FACTOR FOR EACH ALTERNATIVE CRITERION

Criteria	Weight factor
1. Capacity	30
2. Expandability	30
3. Speed	20
4. User friendliness	10
5. Price	10
Total	100

Table III shows the rating given for each criterion.

TABLE III

A RATING OF EACH CRITERION

Criterion	Rating
exellent	10
good	8
average	6
fair	4
weak	0

TABLE IV

FINAL RESULT

Criterion		IBM PC-XT	Apple Macintosh
1. Capacity	30	240	180
2. Expandability	30	300	120
3. Speed	20	120	160
4. User friendliness	10	60	100
5. Price	10	60	60
Total		780	620

Final result in Table IV shows that IBM PC-XT has a higher score. For this example IBM PC-XT should be choosen.

VII. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

The cost of computer hardware and maintenance had impact a backlog in the information system development in the Indonesian Navy. The introduction microcomputer technology in Indonesia offers the opportunity to use this technology for Navy applications.

The microcomputer technology has grown very fast, faster than any technology ever seen. However, microcomputers still have some limitations. Only for an appropriate application this technology will give a benefit to the organization.

Knowing the microcomputer hardware and software characteristics, will help the management of the Indonesian Navy from difficulties for choosing an appropriate microcomputer systems for a certain application.

The weighted criteria decision method was used as a model to choose a microcomputer hardware among many others based on a user requirements.

B. RECOMMENDATIONS

The hardware operating manual and software documentation are very important for users to operate microcomputers. Since English is not a common language in Indonesia,

documentation in Indonesian language will help many users adapting this new technology much easier. Dispullahtal can acts as technical advisor in translating technical references and documentations.

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